SmartBall® Inspection Report

of

North Beach Force Main

(Inspection Date: Tuesday, August 23, 2011)

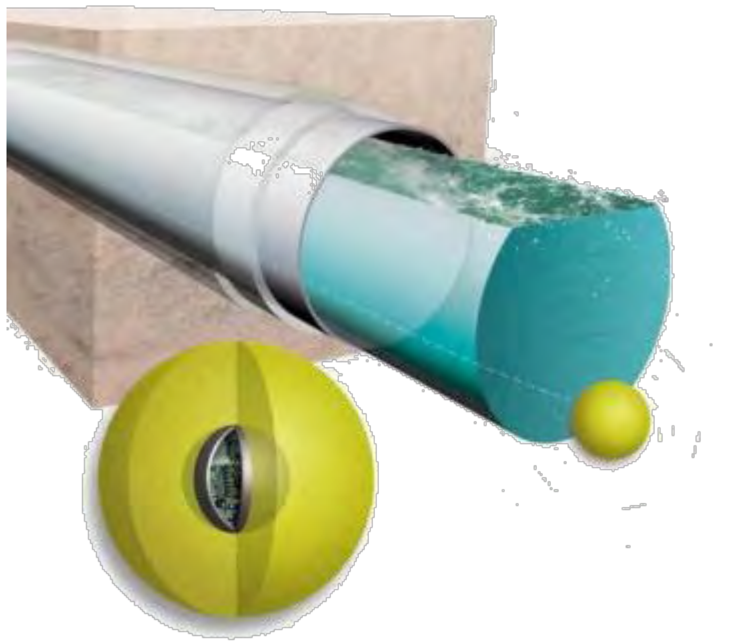

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Table of Contents

1.0 - Executive Summary

The King County Wastewater Treatment Division retained the services of Pure Technologies (Pure) to perform a SmartBall survey of the North Beach Force Main on Tuesday August 23, 2011. The North Beach Force Main is a Cast Iron pipeline that transfers wastewater from North Beach Pumping Station to the Carkeek Pumping Station and Storm Weather Treatment Plant. The purpose of the SmartBall survey is to identify and locate leaks and/or pockets of trapped gas.

The SmartBall was inserted into the pipeline through a 6-inch gate valve supplied by King County outside the North Beach Pumping Station. Acoustic data was collected and recorded as it traversed the pipeline. This data was evaluated to identify acoustic anomalies associated with leaks and pockets of trapped gas.

Pure Technologies detected no acoustic anomalies that resembled leaks and 7 acoustic anomalies that resembled pockets of trapped gas. The results of the inspection are summarized in Tables 1.1 and 1.2.

Table 1.1 - Overview of Subject Pipeline

Pipeline Details	
Total Length of Pipe Surveyed:	7400.0 ft
Pipe Material:	Cast Iron
Diameter of Pipe:	14-inches
Product:	Wastewater

Table 1.2 - Summary of SmartBall Findings

SmartBall Survey Results	
No. of Acoustic Anomalies Resembling Leaks:	0
No. of Acoustic Anomalies Pockets of Trapped Gas:	7
Duration of Survey:	1 hour, 7 minutes
Average SmartBall Velocity:	1.6ft/s

2.0 - Introduction

2.1 - Description of SmartBall Technology

- Overview: SmartBall is an acoustic-based technology that detects anomalous acoustic activity associated with leaks or pockets of trapped gas in pressurized pipes. The SmartBall is composed of an aluminum alloy core that contains a power source, electronic components and instrumentation (including an acoustic sensor, tri-axial accelerometer, tri-axial magnetometer, GPS synchronized ultrasonic transmitter, and temperature sensor). The aluminum core is encapsulated inside a protective outer foam shell, which allows the device to be propelled through the pipeline by creating a larger surface area for the water flow to make contact with. The outer foam shell also helps reduce some low frequency ambient noise that is typically present in the pipeline. The SmartBall assembly is deployed into the flow of a pipeline, traverses the pipeline, and is captured at a point downstream.

Figure 2.1 – SmartBall core and foam shell with SmartBall Receiver (SBR)

- SmartBall Receivers: Tracking the position of the SmartBall in the pipeline is critical for locating important features such as leaks and gas pockets. Figure 2.2 shows an acoustic sensor, which is adhered to the pipe or pipeline appurtenance and is attached to the SmartBall Receiver via coaxial cable. There are special techniques used for both tracking the SmartBall and locating leaks and gas pockets.

    1) SmartBall Tracking: SmartBall Receivers (SBR's), which detect the ultrasonic pulses emitted from the SmartBall, are positioned along the pipeline to track the position of the device as it traverses the pipeline. The SBR devices measure the time it takes for the pulse to travel from the ball to the SBR and calculates an approximate location of the ball. More importantly, as the ball passes the SBR it provides a discrete point where the location of the ball is known at a moment in time, which is very useful when locating leaks and gas pockets.

2) Locating Leaks and Gas Pockets: Once a suspected leak or pocket of trapped gas is identified during the data analysis the positional data for SmartBall is reviewed to determine its location. The methodology used to locate leaks and gas pockets involves creating a velocity profile from the accelerometer data on-board the SmartBall, which is used to best-fit a curve between the discrete points from when the ball passed an SBR. This provides an accurate plot of distance versus time that is used to report the location of leaks or pockets of trapped gas. Absolute position reference points obtained from the SBR are then applied to time stamped data.

Figure 2.2 – Acoustic sensor adhered to flange

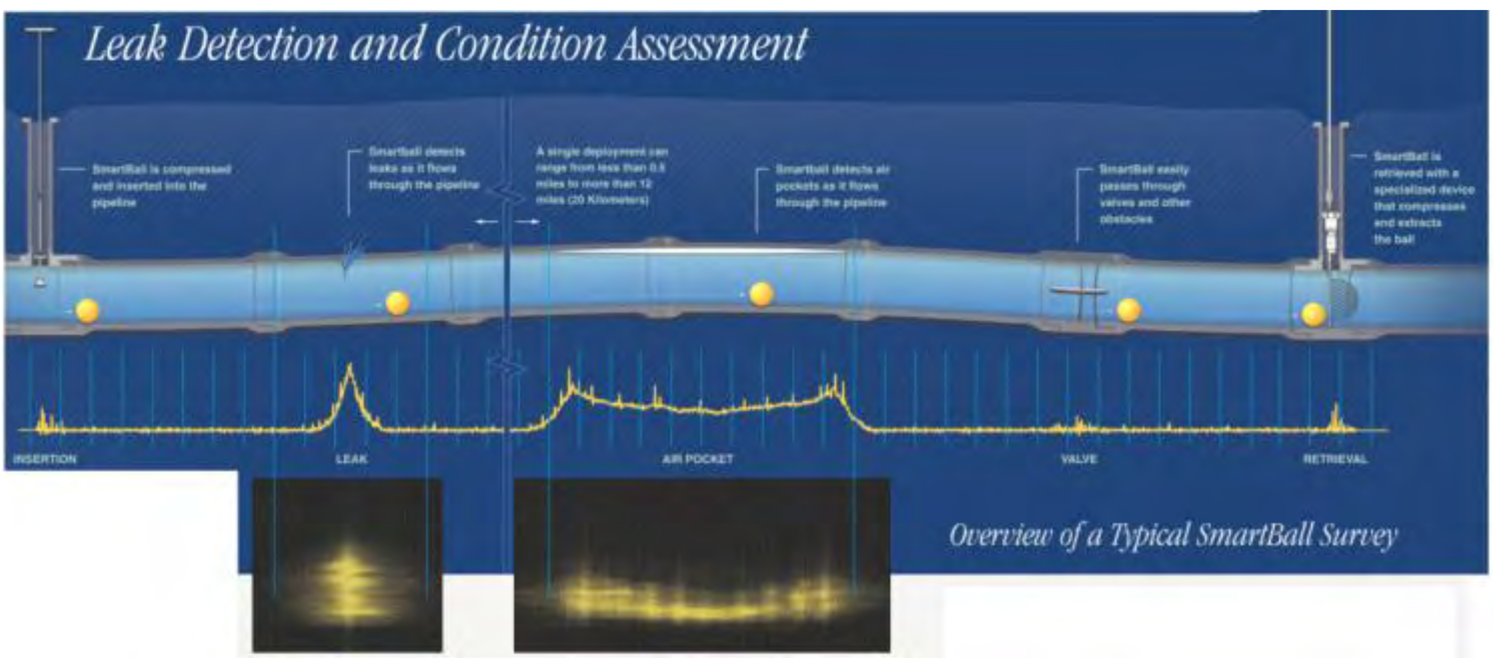


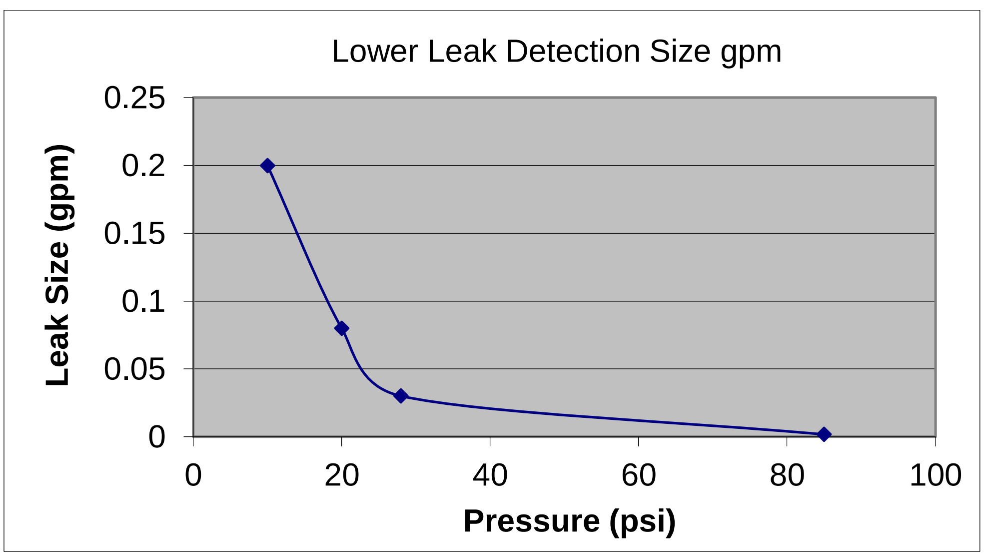
Figure 2.3 – Overview of SmartBall survey

- Advantages of SmartBall: The SmartBall acquires high quality acoustic data which is then evaluated to identify leaks and pockets of trapped gas. Since the SmartBall passes right past each anomaly individually from each acoustic anomaly of interest, three significant advantages are recognized:

    1) Medium and Large Diameter Pipe: SmartBall can be used to detect leaks on medium and large diameter pipes in the range of (>12 inches and over 96 inch diameter) have been successfully inspected by SmartBall. Many conventional leak detection technologies (e.g. correlators) have limitations that preclude their use on medium and large diameter pipe.

    2) Pipe Material: SmartBall's leak detection ability is not affected by pipe material. Because the tool passes by the point at which the acoustic event is being created the pipe wall is not relied on to transmit the acoustic event through the line to a sensor located far away from the actual event of interest which greatly increases it sensitivity and ability to distinguish between separate events.

    3) Sensitivity: The sensitivity of all leak detection technologies is a function of several variables and as a result, no resolute thresholds can be established. However, the acoustic sensor inside the ball always passes within one pipe diameter of a leak and therefore it can be used to identify very small leaks due to the proximity of the tool to the leak. For example, on a 150 psi pipeline during a blind simulation was confirmed that a leak of 0.15 gallons per hour could be detected. Other experiences have confirmed this ability, however variables associated with a specific leak should be understood. For pipes with significant pressure of 50 psi or more, under ideal conditions (low ambient noise), SmartBall may detect leaks as small as 0.15 gallons per hour. However for pipelines that operate at pressures less than 10 psi and/or include less than ideal conditions (high ambient noise), small leaks in this range may not be identified



4) Length of Survey: SmartBall has the ability to record acoustic data for over 12 hours. Depending on flow rates, the tool can inspect long lengths of pipe during a single deployment. The longest single recording within a water pipeline with a single deployment had the SmartBall record acoustic data and inspect a length of pipeline exceeding 30 miles.

- Limitations of SmartBall: All non-destructive testing technologies have unique capabilities and limitations that affect the accuracy and efficacy of the technology. SmartBall has the following limitations:

1) Minimum Pressure: The acoustic activity associated with a leak is derived from the pressure differential across the pipe wall. With little to no pressure differential the device will not detect leakage as there will be no associated acoustic activity. Pressure is not required to identify locations of trapped gas.

2) Ambient Noise: SmartBall detects and reports anomalies that have acoustic characteristics similar to leaks on pressurized pipelines. However, other forms of ambient noise may be identified during the data analysis. For medium and large leaks there is very little that can match these acoustic characteristics and therefore, these events are almost certainly leaks. For small leaks, there may be other forms of ambient noise that are difficult to evaluate. Pure has invested significant resources into characterizing acoustic anomalies and consequently believes leaks described in this report are leaks, unless otherwise noted. However, unknown pressure reducing valves, cracked valves in close proximity, interconnected pipelines that have not been completely isolated and leaks in pipelines immediately adjacent to the subject pipe do contain a similar acoustic signature and could be reported as leaks in this report. Cars, pumps, boat traffic and other forms of common ambient noise should not be reported as leaks as they contain different acoustic signatures.

3) Reported Locations: Reported locations contained in this report are believed to be accurate to within +/- 5 feet. This is based on project experience and the limitations of the technologies used to calculate location. There are also several other factors that would decrease the accuracy of locating leaks and gas pockets: if SBR devices are more than 4000 feet (3/4 of a mile) apart (pipe distance/station numbers), the location/station of SBR's are unknown, or the drawings and/or dimensions provided by the client are incorrect.

Figure 2.4 – Example excavation to expose leaking joint

- <u>About Gas Pockets:</u> The SmartBall detected pockets of trapped gas along this pipeline which could indicate the pipeline may benefit from additional air release valves. Certain types of trapped gas common in sewage force mains may contain a highly corrosive H2S mixture that can quickly deteriorate the pipe wall material.

2.2 - Description of Subject Pipeline

The North Beach Force Main is a Cast Iron pipeline that transfers wastewater from the North Beach Pumping Station to the Carkeek Pumping Station. The pipeline was constructed in 1963 and has a typical operating pressure between 10 psi to 40 psi. The SmartBall survey started outside the North Beach Pumping Station and ended at the Carkeek Pumping Station. During the SmartBall survey the pressure in the pipeline was estimated to vary between ~15 and ~25 psi along the pipeline. The Client reported that the Pressures vary due to the changes in the elevation of the pipeline. The force main drops roughly 35 feet in elevation between the pump station and the beach. The pipeline subsequently comes ~ 45 feet up in elevation to the discharge point at the Carkeek Pump station and Storm Weather Treatment Plant. The pressure at the pump at the inspection flow rate was ~15 psi based on reference to pump test data and the pump running at approximately 800 RPM. The 40 psi value at the pump correlates to the pumps operating at full speed. We did not have a working pressure gauge on the pump, header, or force main the day of the inspection. Based on the lack of measured pressures I have listed the values as approximate.

The approximate pipeline location is displayed on the aerial photograph below in Figure 2.5.

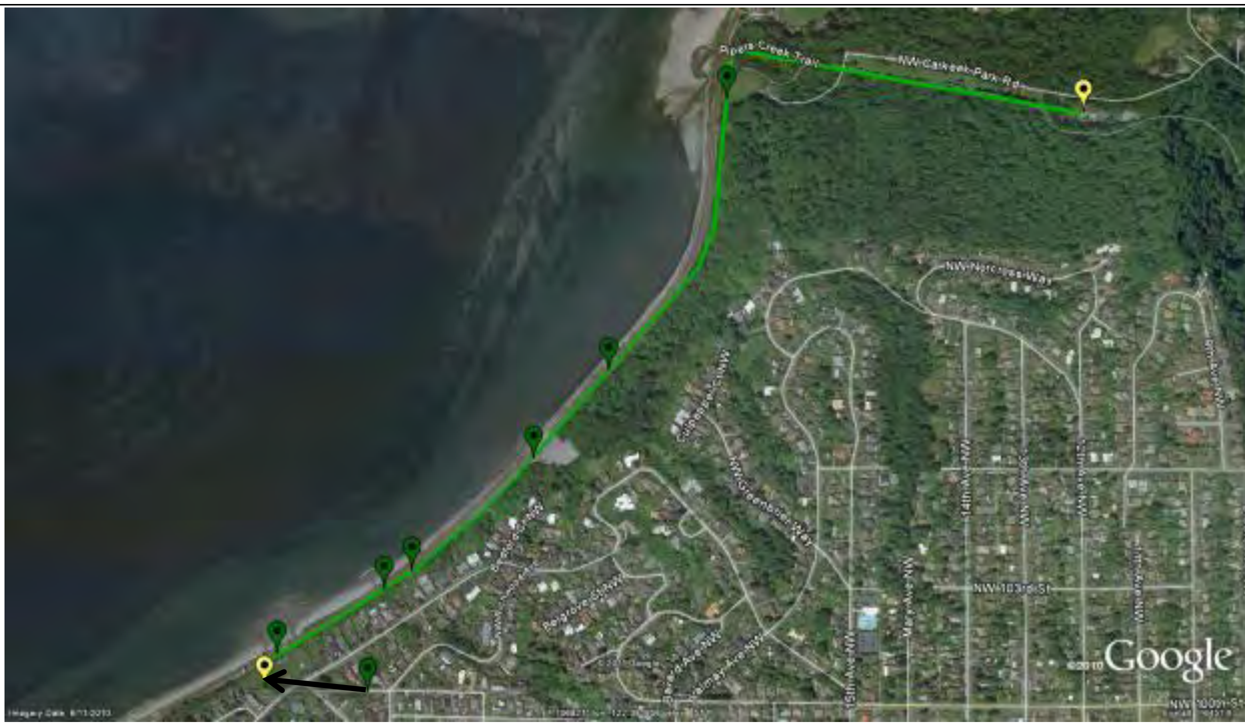


Figure 2.5 –General layout of the pipeline inspected for King County

Approximate sensor locations ( )

and gas pocket locations ( ) for the inspection

3.0 - SmartBall Survey Logistics and Results

3.1 - Planning Document

Prior to the execution of the project, Pure reviewed the site and pipeline drawings for suitability and prepared a Planning Document that described the upcoming SmartBall survey. A copy of the Planning Document is included in Appendix B.

3.2 - SmartBall Insertion

The insertion tool was used to keep the foam and SmartBall core contained as it is inserted through the client's 6-inch gate valve where it is then released into the flow.

Figure 3.1 – Insertion site

The insertion tool protects the SmartBall from being stuck or damaged by any buildup or debris internal to the insertion valve and riser.

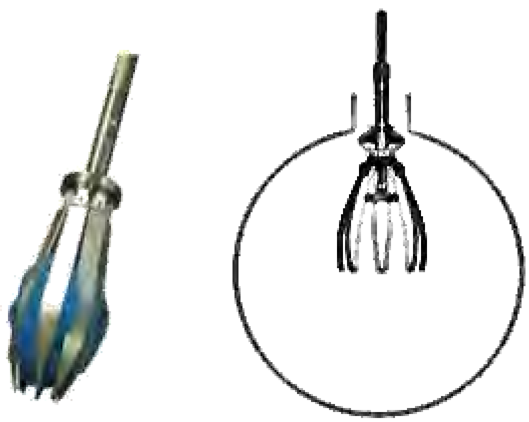


Figure 3.2a and 3.2b – Insertion tool details

3.3 - SmartBall Capture and Extraction

The SmartBall was extracted using a Bar Screen located inside the Carkeek Pumping Station and Store Weather Treatment Plant.

Figure 3.3 – Extraction site

3.4 - SBR Locations

Two (2) SmartBall acoustic sensors were placed along the line to track the progress of the tool as it traversed the pipeline. The SmartBall Receivers were connected to these sensors on the pipeline at the locations indicated in Table 3.1 and are shown in Appendix A. The inspection was completed in 1 hour, 7 minutes. The times at which the tool passed the SmartBall Receiver locations are also summarized in Table 3.1.

Figure 3.5: Example of Sensor mounted to pipeline

Table 3.1 – SmartBall Receiver Locations

Distance from Start	Elapsed Time Since Ball Synchronization (hh:mm:ss)	Location Description	SBR #	GPS Location
0ft	02:33:21	Insertion	SBR #1	47.7016, -122.3906
6,401ft	03:41:11	gravity connection	SBR #2	47.7112, -122.3742

3.5 - Tracking the Position of the SmartBall

Individual SmartBall Receivers (SBR's) were used to track the ball's progress - the distance between and location of these SBR's is based on the information and drawings provided by King County. The SBR's that acquired data for this survey are shown in Appendix A.

Figure 3.6 shows a plot of the distance the SmartBall traveled versus time (above) and data from the SBR's indicating the absolute position of the SmartBall (below). The slope of the blue line indicates the instantaneous velocity of the SmartBall. Figure 3.7 shows the instantaneous velocity of the SmartBall as it traveled through the pipeline. The small velocity dips have no great significance and may be related to the ball not rolling perfectly along the bottom of the pipeline. This may be caused by small debris, bends, inclines, declines, joint or similar pipeline asset. The location of these small dips was not able to be conclusively correlated with the pipe drawings provided to any pipe asset.

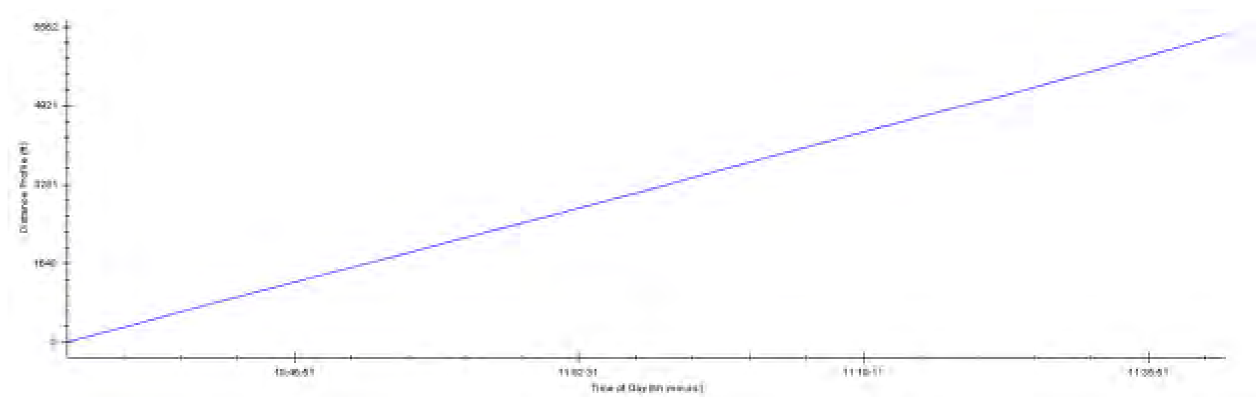


Figure 3.6: Position profile of the SmartBall vs. Time of Day for the August 23, 2011 inspection

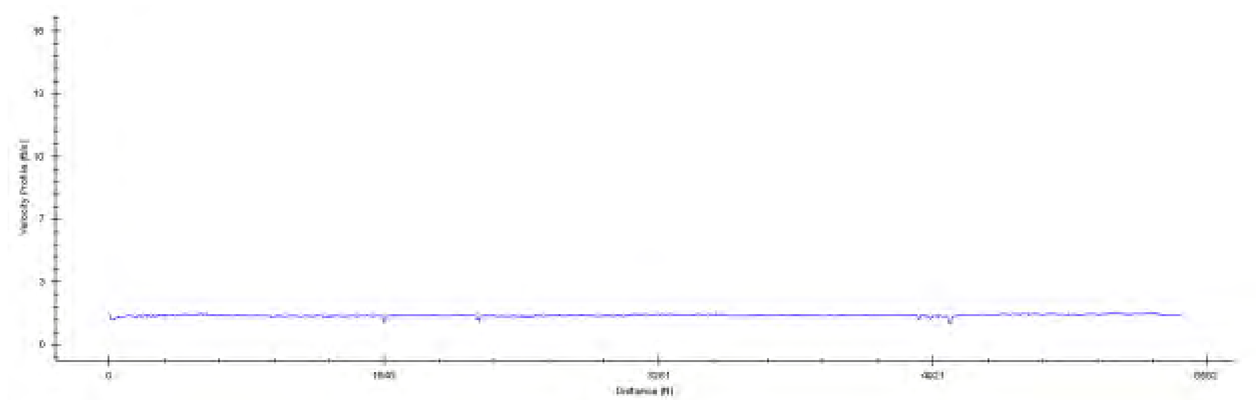


Figure 3.7 Velocity profile of the SmartBall vs. distance travelled for the August 23, 2011

.6 - Summary of Leaks and Air Pockets

Upon screening the acoustic data with specialized software and by trained SmartBall technicians, no acoustic anomalies resembling leaks were found within the data collected by the SmartBall. This data was peer reviewed to ensure that no events were overlooked. This indicates that there are no leaks present within the detection limit of the SmartBall for this line, under the operating conditions at the time of inspection.

Figure 3.8 shows the value of the acoustic profile of the inspection as detected by the SmartBall with respect to the position within the pipeline. The critical findings of the pipeline inspection are summarized in Table 3.2.

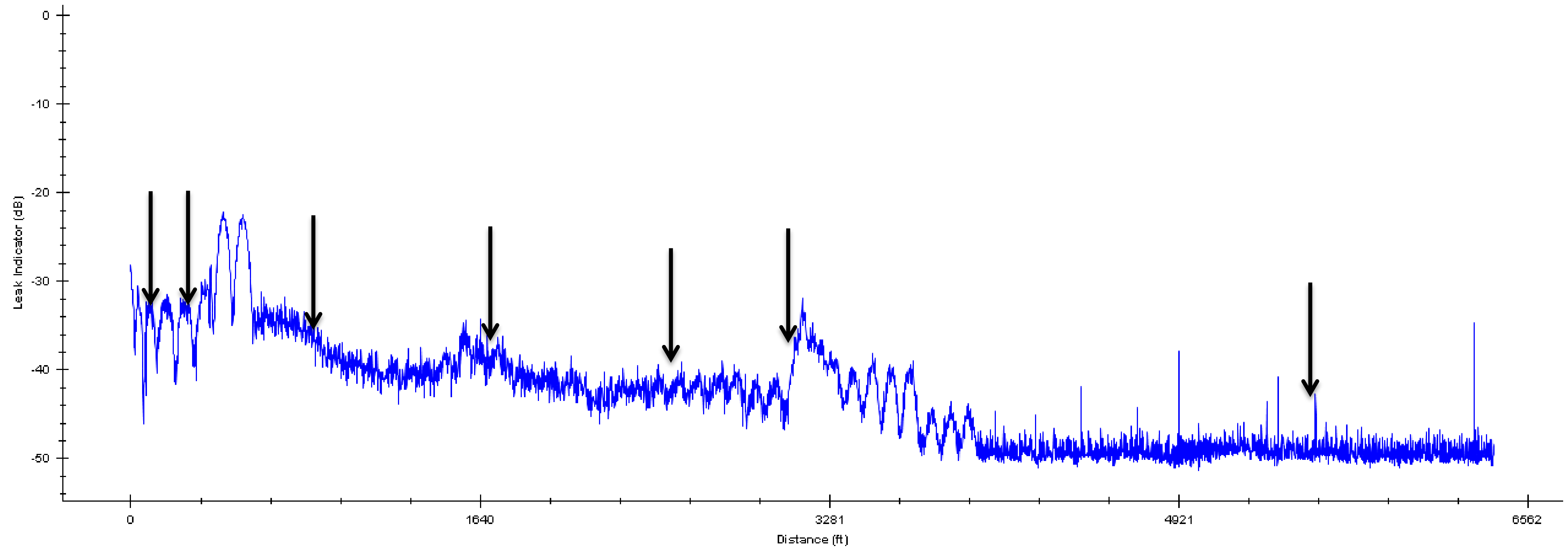


Figure 3.8: Acoustic summary of the SmartBall inspection vs. distance travelled for the August 23, 2011 inspection

↓ *-Locations of gas pockets*

As seen in Figure 3.8, several acoustic peaks were identified along the force main alignment however these are likely caused by ambient or background sound by external sources such as pump noise or nearby traffic. These sources of ambient noise are easily distinguishable from leaks or other points of interest with further analysis of the associated frequencies. Ambient noise is generally at a much lower frequency than the frequencies generated by a leak or gas pocket. Figure 3.9 shows an example of an acoustic peak found during the survey. Figure 3.10 shows an example of a gas pocket found during a survey. The signal in Figure 3.10 is more distinguishable than the signal shown in Figure 3.9.

The difference between trapped gas pockets and leaks within the data are displayed below from figures 3.9 to 3.12. A general indication of a leak is a consistent build of the acoustic indicator and then decline once the ball passes the leak location. The audio playback of these regions also helps the data analyst to distinguish these areas of interest from each other.

Acoustic Indicator

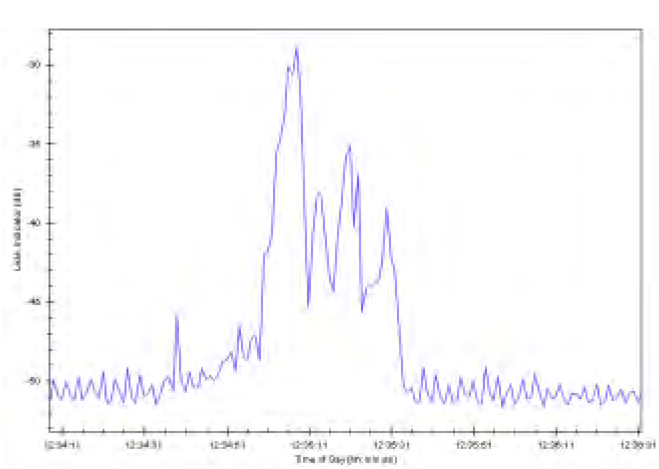


Figure 3.9a: Indication Power of North Beach Force Main Acoustic Peak

Frequency Spectrum

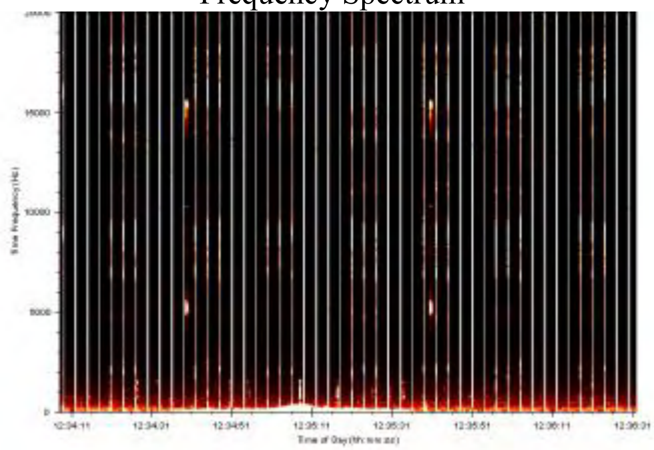


Figure 3.9b: Frequency Spectrum of North Beach Force Main Acoustic Peak

Acoustic Indicator

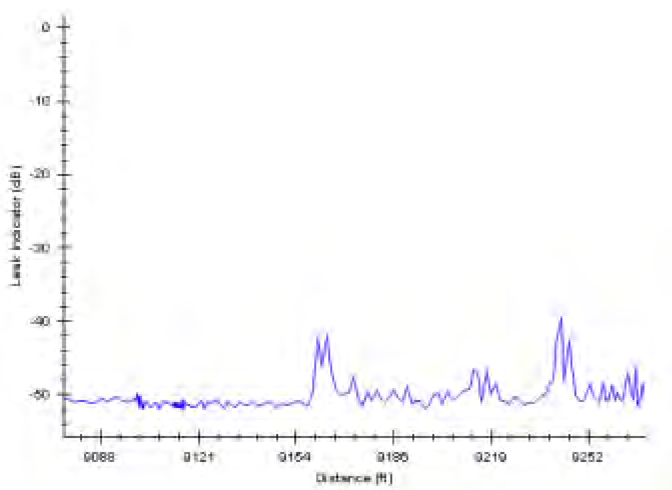


Figure 3.10a: Example of Indication Power of a Confirmed Gas Pocket

Frequency Spectrum

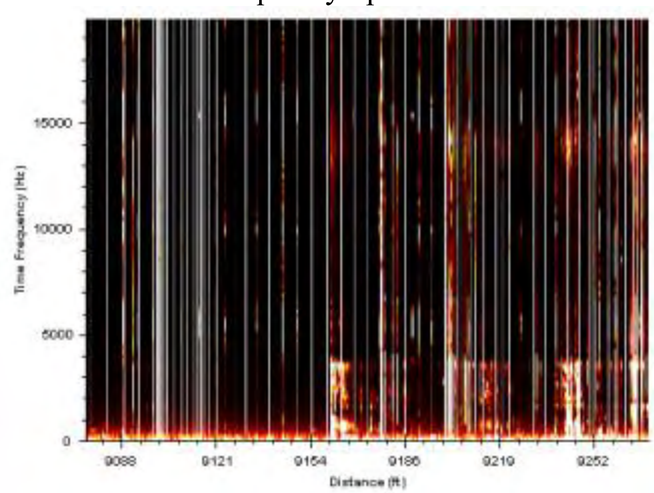


Figure 3.10b: Example Frequency Spectrum of a Confirmed Gas Pocket

Figure 3.11 provides another example an acoustic peak from the survey; the frequency of the noise recorded by the SmartBall shows no indication of a leak or gas pocket. Figure 3.12 shows an example of the frequency spectrum and leak indicator graph for a leak. While the North Beach shows a high indication it doesn't have the corresponding frequency spectrum that the leak in figure 3.12b shows.

Acoustic Indicator

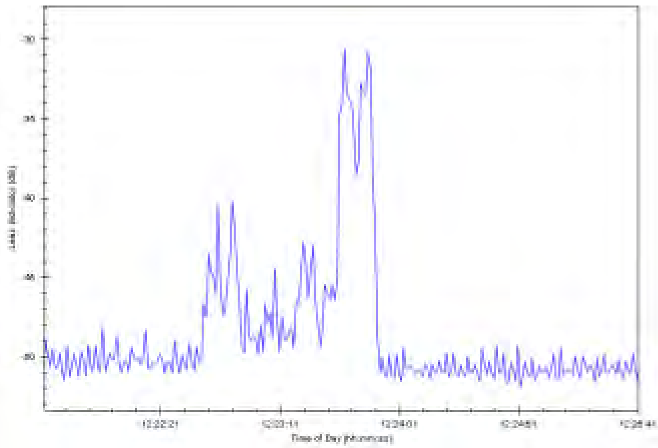


Figure 3.11a: Indication Power of a example Force Main Acoustic Peak

Frequency Spectrum

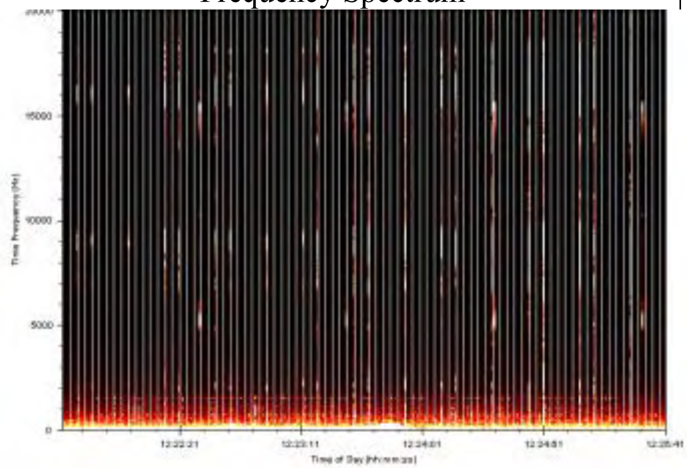


Figure 3.11b: Frequency Spectrum of Anomaly

Acoustic Indicator

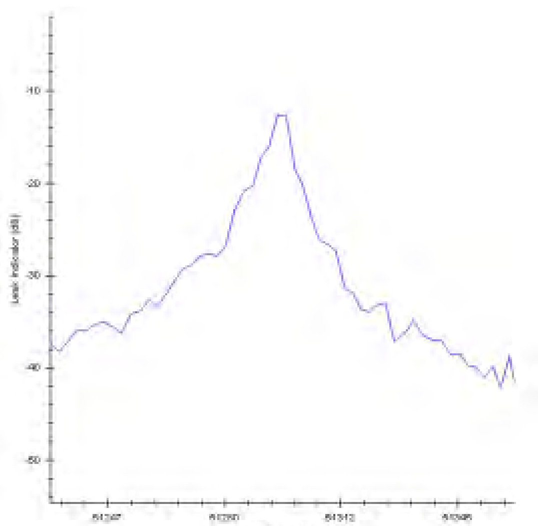


Figure 3.12a: Example of Indication Power of a Confirmed Leak

Frequency Spectrum

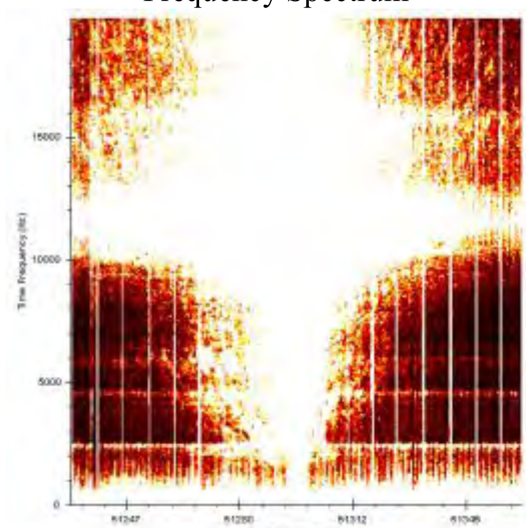


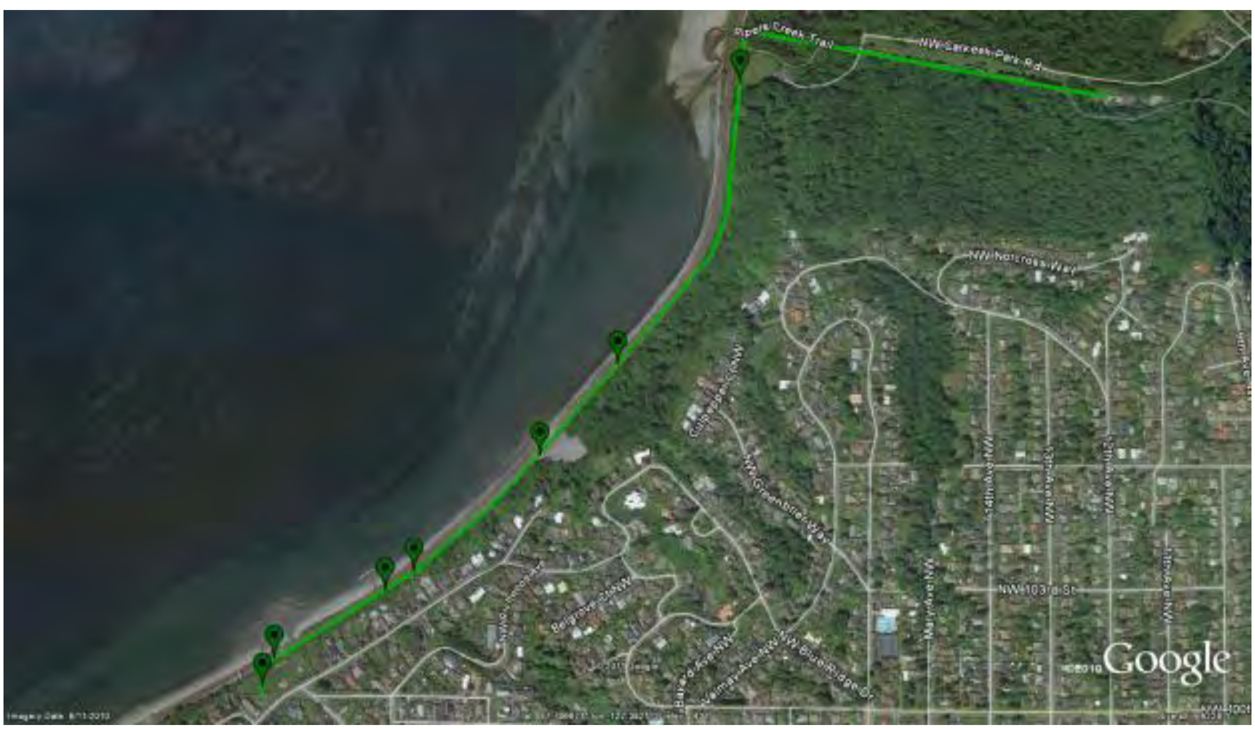
Figure 3.12b: Example Frequency Spectrum of a Confirmed Leak

Table 3.2 provides a summary of the points of interest from the SmartBall survey.

Below is a summary table of all important milestones that the ball was determined to have passed during the inspection.

Table 3.2 – General points of interest

Distance from Insertion	Chainage	Time Since Launch	Description	GPS Location
0ft	0+57	00:00:00	Insertion	47.7016, -122.3906
23ft	0+80	00:00:17	Gas Pocket (~28ft)	47.7016, -122.3906
299ft	3+56	00:03:21	Gas Pocket (~26ft)	47.7022, -122.3901
1,082ft	11+39	00:11:37	Gas Pocket (~119ft)	47.7032, -122.3876
1,310ft	13+67	00:14:06	Gas Pocket (~27ft)	47.7035, -122.3869
2,285ft	23+42	00:24:38	Gas Pocket (~8ft)	47.7053, -122.3842
3,045ft	31+02	00:32:50	Gas Pocket (~78ft)	47.7069, -122.3821
4,612ft	46+69	00:49:16	Gas Pocket (~9ft)	47.7111, -122.3795
6,401ft	64+58	01:07:50	SBR	47.7112, -122.3742



4.0 Sites of Interest – Details

Details on acoustic anomalies of interest that were detected during the SmartBall survey are provided below.

Site of Interest #1 - Gas Pocket

Chainage at Location:	0+80
Distance to Nearest Sensor:	23.4 ft after Insertion
Distance from Insertion Point:	23.4 ft
Time Since Start of Rolling:	00:00:17
Time Since Activated:	02:33:38
Time of Tool Pass (GMT-8:00):	10:32:49 AM
Approximate Location: represent only approximate GPS location	47.7016, -122.3906 * *Based on Google Earth information which is as accurate as possible
Acoustic Profile of Leak: Use by Pure to Determine Approximate Leak Size	-36.3 dB (measured acoustically in decibels)
Estimated Size (Small/Med/Large): Based on proprietary algorithm and analysis of above quantification	~28ft

Acoustic Indicator

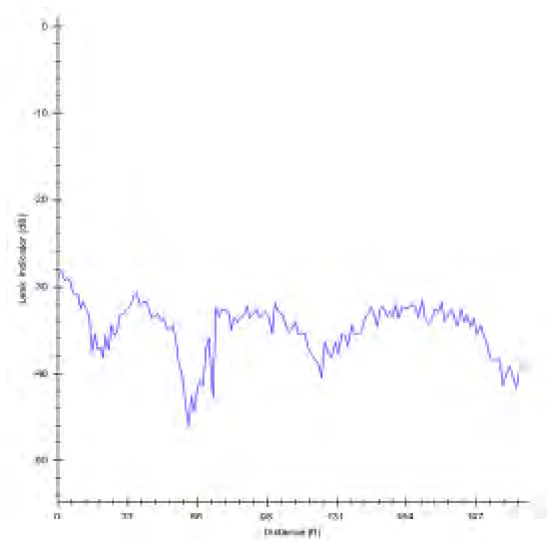


Figure 4.1a: Acoustic Indication Power of Anomaly

Frequency Spectrum

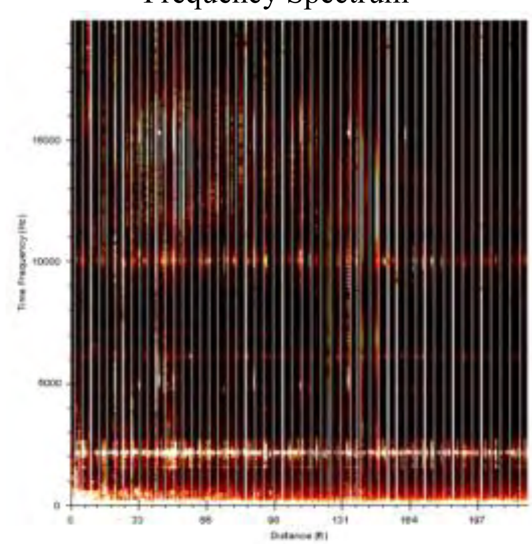


Figure 4.1b: Frequency Spectrum of Anomaly

Approximate Location

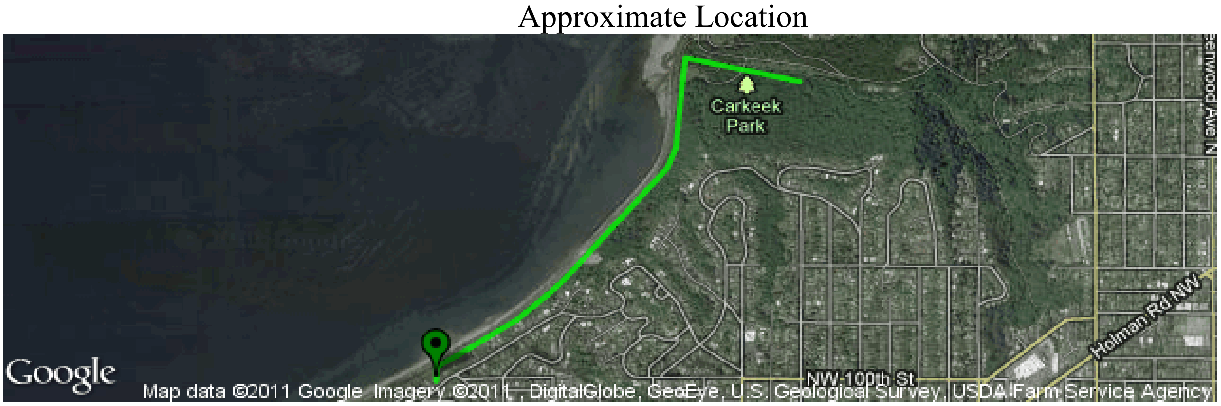


Figure 4.1c: Approximate Location of Acoustic Anomaly

Site of Interest #2 - Gas Pocket

Chainage at Location:	3+56
Distance to Nearest Sensor:	299.4 ft after Insertion
Distance from Insertion Point:	299.4 ft
Time Since Start of Rolling:	00:03:21
Time Since Activated:	02:36:42
Time of Tool Pass (GMT-8:00):	10:35:53 AM
Approximate Location: represent only approximate GPS location	47.7022, -122.3901 * *Based on Google Earth information which is as accurate as possible
Acoustic Profile of Leak: Use by Pure to Determine Approximate Leak Size	-39.2 dB (measured acoustically in decibels)
Estimated Size (Small/Med/Large): Based on proprietary algorithm and analysis of above quantification	~26ft

Acoustic Indicator

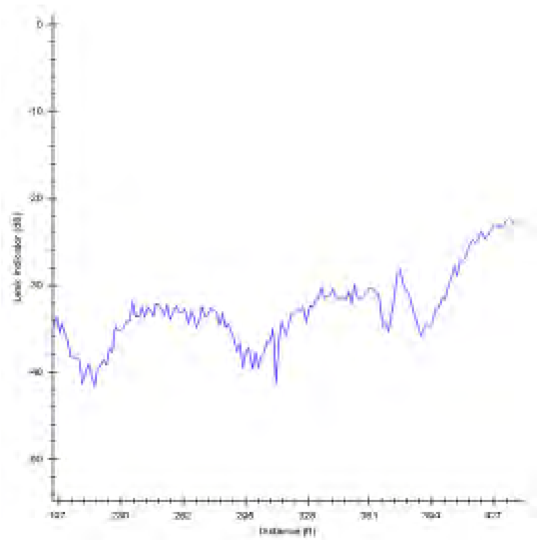


Figure 4.2a: Acoustic Indication Power of Anomaly

Frequency Spectrum

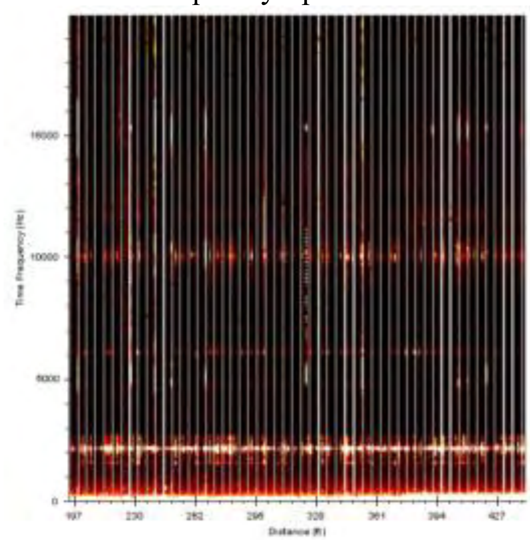


Figure 4.2b: Frequency Spectrum of Anomaly

Approximate Location

Figure 4.2c: Approximate Location of Acoustic Anomaly

Site of Interest #3 - Gas Pocket

Chainage at Location:	11+39
Distance to Nearest Sensor:	1,082.1 ft after Insertion
Distance from Insertion Point:	1,082.1 ft
Time Since Start of Rolling:	00:11:37
Time Since Activated:	02:44:58
Time of Tool Pass (GMT-8:00):	10:44:09 AM
Approximate Location: represent only approximate GPS location	47.7032, -122.3876 * *Based on Google Earth information which is as accurate as possible
Acoustic Profile of Leak: Use by Pure to Determine Approximate Leak Size	-39.6 dB (measured acoustically in decibels)
Estimated Size (Small/Med/Large): Based on proprietary algorithm and analysis of above quantification	~119ft

Acoustic Indicator

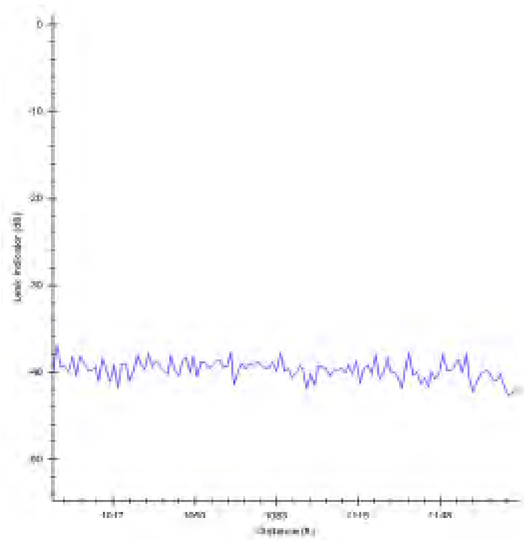


Figure 4.3a: Acoustic Indication Power of Anomaly

Frequency Spectrum

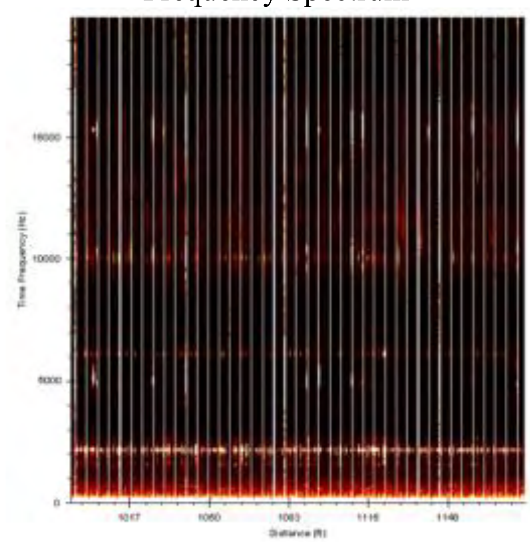


Figure 4.3b: Frequency Spectrum of Anomaly

Approximate Location

Figure 4.3c: Approximate Location of Acoustic Anomaly

Site of Interest #4 - Gas Pocket

Chainage at Location:	13+67
Distance to Nearest Sensor:	1,310.3 ft after Insertion
Distance from Insertion Point:	1,310.3 ft
Time Since Start of Rolling:	00:14:06
Time Since Activated:	02:47:27
Time of Tool Pass (GMT-8:00):	10:46:38 AM
Approximate Location: represent only approximate GPS location	47.7035, -122.3869 * *Based on Google Earth information which is as accurate as possible
Acoustic Profile of Leak: Use by Pure to Determine Approximate Leak Size	-40.0 dB (measured acoustically in decibels)
Estimated Size (Small/Med/Large): Based on proprietary algorithm and analysis of above quantification	~27ft

Acoustic Indicator

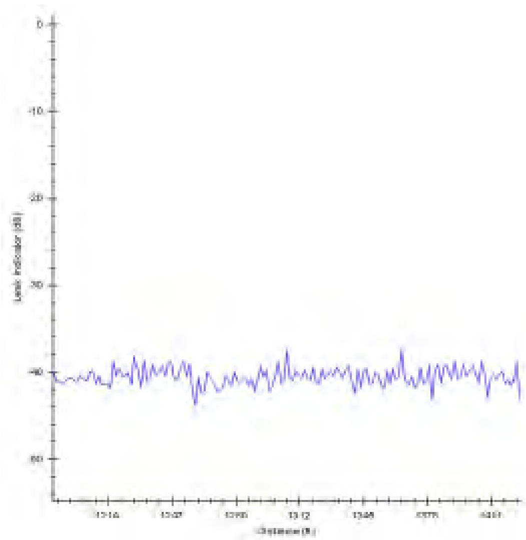


Figure 4.4a: Acoustic Indication Power of Anomaly

Frequency Spectrum

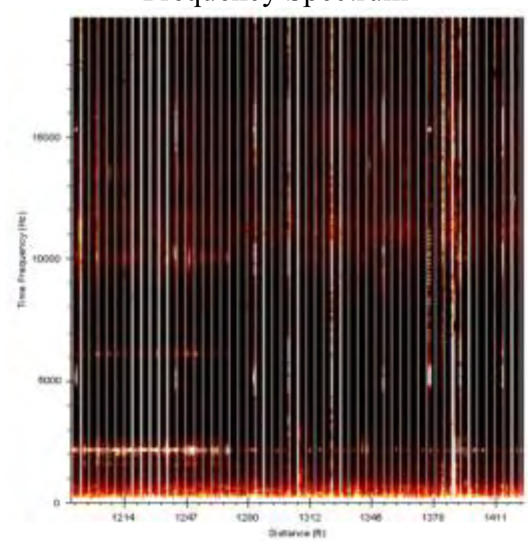


Figure 4.4b: Frequency Spectrum of Anomaly

Approximate Location

Figure 4.4c: Approximate Location of Acoustic Anomaly

Site of Interest #5 - Gas Pocket

Chainage at Location:	23+42
Distance to Nearest Sensor:	2,284.8 ft after Insertion
Distance from Insertion Point:	2,284.8 ft
Time Since Start of Rolling:	00:24:38
Time Since Activated:	02:57:59
Time of Tool Pass (GMT-8:00):	10:57:10 AM
Approximate Location: represent only approximate GPS location	47.7053, -122.3842 * *Based on Google Earth information which is as accurate as possible
Acoustic Profile of Leak: Use by Pure to Determine Approximate Leak Size	-42.9 dB (measured acoustically in decibels)
Estimated Size (Small/Med/Large): Based on proprietary algorithm and analysis of above quantification	~8ft

Acoustic Indicator	Frequency Spectrum

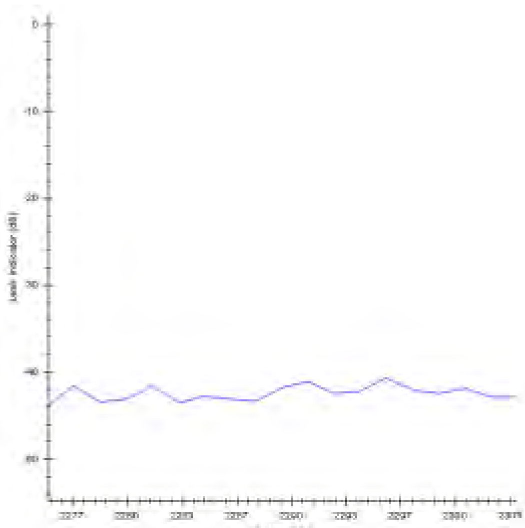
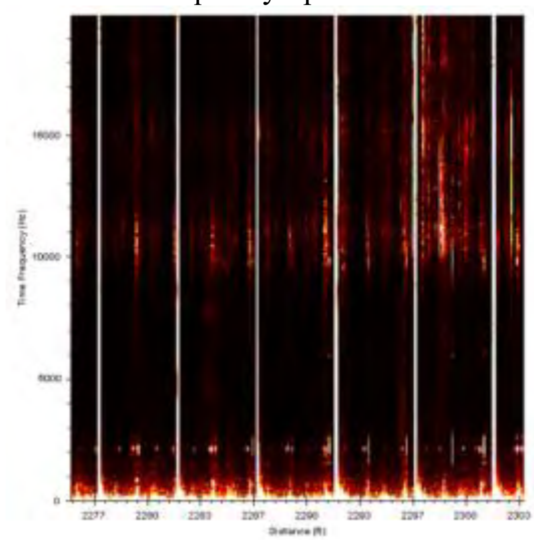

	

Figure 4.5a: Acoustic Indication Power of Anomaly	Figure 4.5b: Frequency Spectrum of Anomaly

Approximate Location

Figure 4.5c: Approximate Location of Acoustic Anomaly

Site of Interest #6 - Gas Pocket

Chainage at Location:	31+02
Distance to Nearest Sensor:	3,044.8 ft after Insertion
Distance from Insertion Point:	3,044.8 ft
Time Since Start of Rolling:	00:32:50
Time Since Activated:	03:06:11
Time of Tool Pass (GMT-8:00):	11:05:22 AM
Approximate Location: represent only approximate GPS location	47.7069, -122.3821 * *Based on Google Earth information which is as accurate as possible
Acoustic Profile of Leak: Use by Pure to Determine Approximate Leak Size	-43.3 dB (measured acoustically in decibels)
Estimated Size (Small/Med/Large): Based on proprietary algorithm and analysis of above quantification	~78ft

Acoustic Indicator	Frequency Spectrum

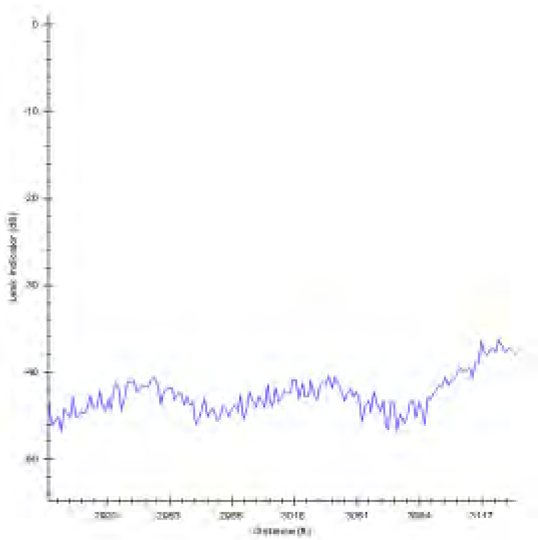
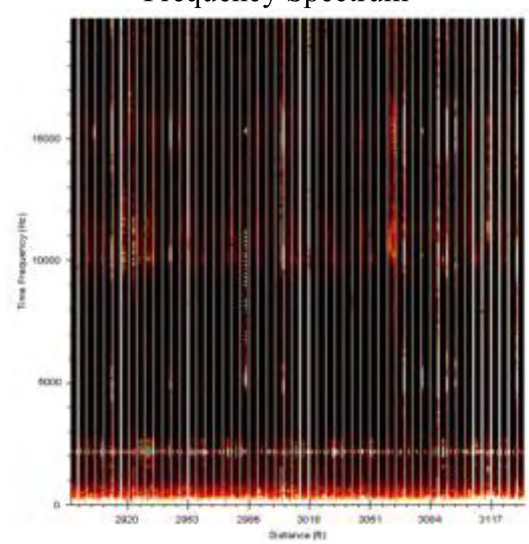

	

Figure 4.6a: Acoustic Indication Power of Anomaly	Figure 4.6b: Frequency Spectrum of Anomaly

Approximate Location

Figure 4.6c: Approximate Location of Acoustic Anomaly

Site of Interest #7 - Gas Pocket

Chainage at Location:	46+69
Distance to Nearest Sensor:	1,789.3 ft before Extraction
Distance from Insertion Point:	4,611.7 ft
Time Since Start of Rolling:	00:49:16
Time Since Activated:	03:22:37
Time of Tool Pass (GMT-8:00):	11:21:48 AM
Approximate Location: represent only approximate GPS location	47.7111, -122.3795 * *Based on Google Earth information which is as accurate as possible
Acoustic Profile of Leak: Use by Pure to Determine Approximate Leak Size	-49.5 dB (measured acoustically in decibels)
Estimated Size (Small/Med/Large): Based on proprietary algorithm and analysis of above quantification	~9ft

Acoustic Indicator

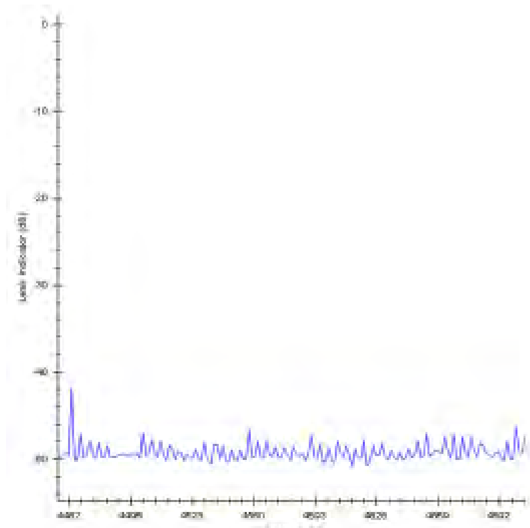


Figure 4.7a: Acoustic Indication Power of Anomaly

Frequency Spectrum

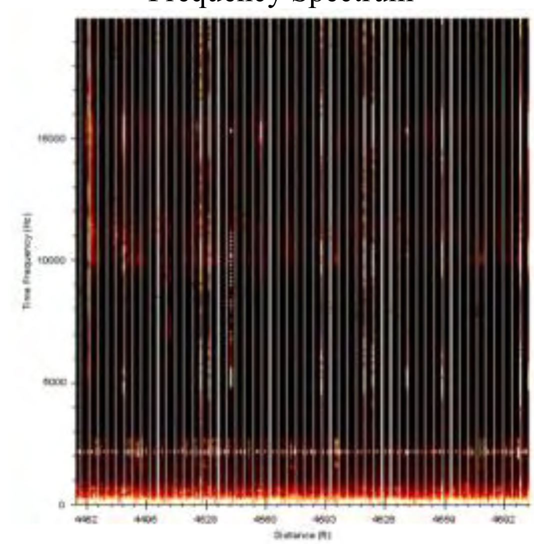


Figure 4.7b: Frequency Spectrum of Anomaly

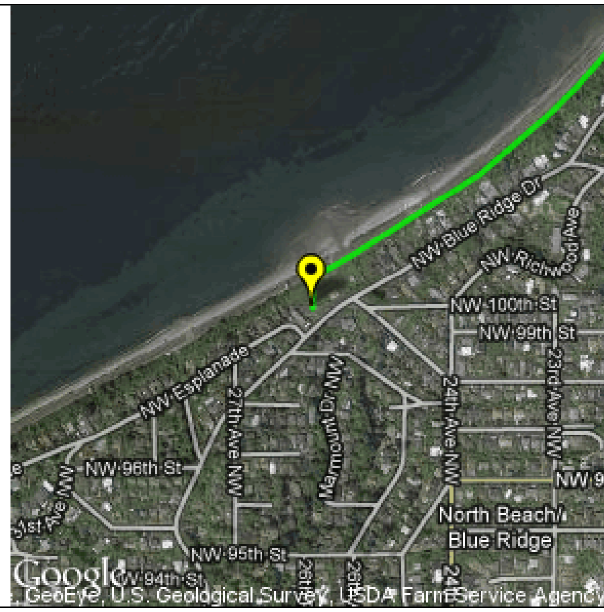
Approximate Location

Figure 4.7c: Approximate Location of Acoustic Anomaly

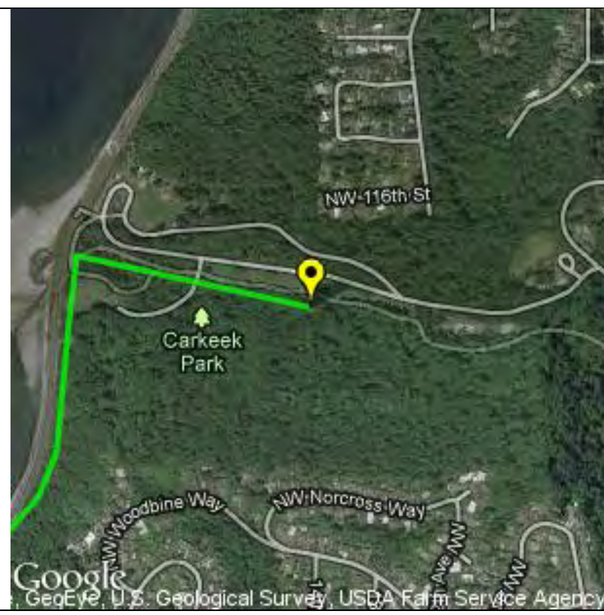
Appendix A: Ball Tracking Sensor Locations

For inspection of North Beach Force Main completed Tuesday August 23, 2011

AGM Location ID	Insertion
Station	0+57
Distance from Launch	0ft
Time of Departure (GMT-8:00)	10:32 AM
Latitude	47.7016
Longitude	-122.3906



AGM Location ID	gravity connection
Station	64+58
Distance from Launch	6,401ft
Time of Arrival (GMT-8:00)	11:40 AM
Latitude	47.7112
Longitude	-122.3742



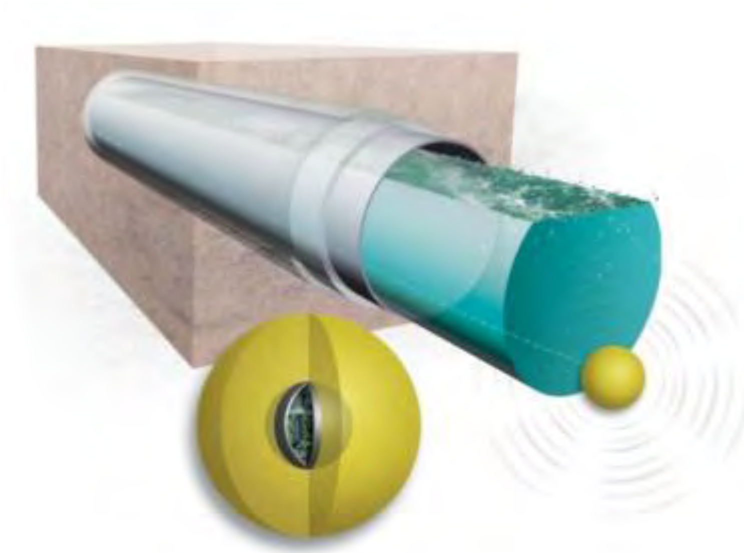
*Stationing and Distances for the items in the table above are as identified from the plans and details provided to Pure Technologies Ltd by Client

__Appendix B: Planning Document__

Below is the planning document used for this inspection.

SmartBall Project Plan

North Beach Force Main



Submitted To:

King County

July 26, 2011

Table of Contents

Location – Seattle, Washington, USA
North Beach Force Main
Diameter: 14-inch
Material: Cast Iron
Length (according to drawings): 7094 feet
Length (according to Google Earth): 7447 feet
Expected Pressure – 30 psi
Expected Flow Rate ~ 1.5 ft/s

Purpose

The intent of this document is to address planning issues related to the Pure Technologies (Pure) SmartBall inspection for King County along the North Beach Force Main. The purpose of the acoustic inspection is to locate leaks and pockets of trapped gas present that may be present at the time of inspection. The information gathered will be analyzed to identify areas of interest. A final report will be provided 2 weeks after the inspection indicating the approximate size and location of the anomaly.

Location

The North Beach Force Main is a 14-inch pipeline constructed of Cast Iron. This pipeline will be inspected from the North Beach Pumping Station to the Carkeek Pumping Station.

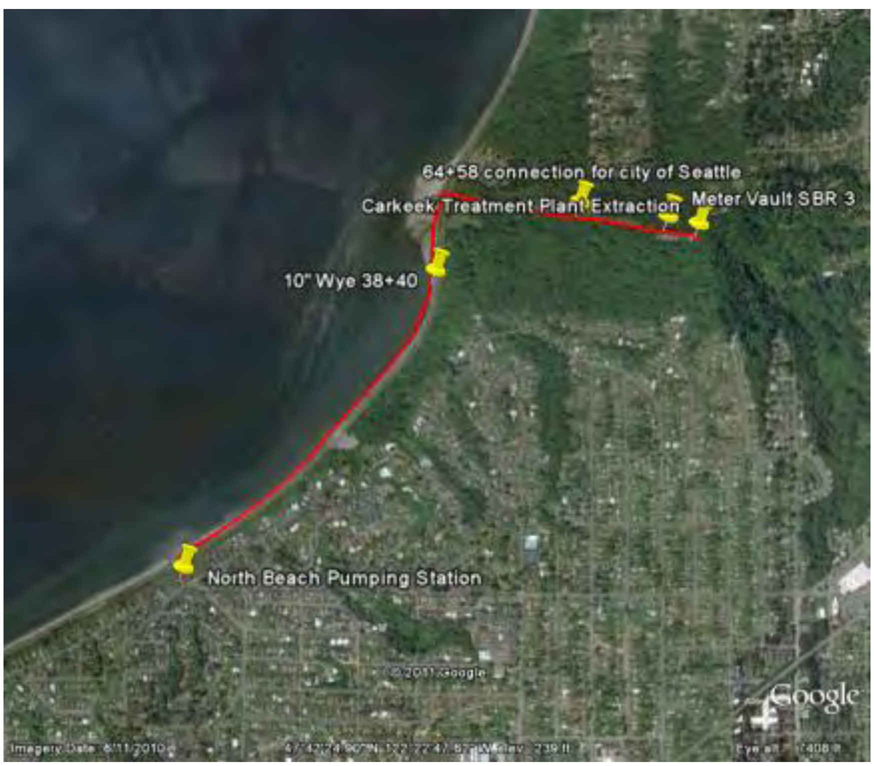


Figure 1. North Beach Force Main
Approximately 7100 feet to be inspected by SmartBall

Inspection Methodology

The SmartBall leak detection system consists of an inner aluminum alloy core containing an acoustic sensor and circuitry. The aluminum core is in turn encapsulated inside a foam ball. The foam ball provides the appropriate mass (size and overall weight) that allows the device to be propelled by the water flow. It also deadens any sound that the device might make as it traverses the pipeline. The foam ball and core are inserted into a fully flowing and operational pipeline and released to allow the flow to carry the ball downstream. While the ball is traversing the pipeline, it makes a continuous recording of all the acoustic activity in the pipeline. This data is later evaluated to determine the presence and location of any leaks or pockets of trapped gas.

A transponder within the SmartBall core emits high frequency, timed acoustic signals that are detected by proprietary SmartBall Receivers (SBR's) on the surface. The SBR's track the SmartBall's movement and location, correlating its position at any time in reference to acoustic events recorded on the acoustic sensor contained within the SmartBall.

Figure 2 - SmartBall Core and Outer Foam Ball with SmartBall Receiver (SBR) unit

Once the SmartBall has traversed the entire pipeline length, it is typically captured and retrieved either in a specially engineered net which is inserted through a 4-inch port or an open channel.

SmartBall requires a four inch minimum flange opening with a full port valve for insertion into the pipeline. Once deployed, it can move through in-line valves, reducers, and other fittings, as well as navigate turns and profile changes.

Identification of a leak with acoustic sensors is a straightforward and proven technique. Field testing and research shows that the SmartBall technology can detect leaks as small as 0.25 gallons per hour under ideal conditions.

Figure 3 - Insertion equipment used to insert SmartBall into a pipeline

Team Overview

The following table gives a brief description of the companies and organizations involved in the inspection and their required duties.

Role Overview		
Company / Organization	**Description**	**Responsibilities / Duties**
King County	Owner	• Initiated contract • Scope issues • Final decision maker
Pure Technologies (PURE)	Pipeline Inspection Contractor	• SmartBall Inspection • Sensor Install
Road Construction Northwest INC.	Mechanical Contractor	• Install 6" Hot Tap • Prime Contractor

Table 1 – Communication Overview

Inspection Schedule Overview

SmartBall Inspection Schedule Overview			
Date	**Task**	**Approximate Timing**	**Owner**
Week of July 25, 2011	Install fitting at launch point		Road Construction
Tuesday, August 16th	Inspect SmartBall equipment	Afternoon	PURE
Wednesday, August 17th	Attach SmartBall Sensors	8:00 – 10:00	PURE and King County
	SmartBall Pre Launch	10:00 -11:00	PURE and King County
	SmartBall Inspection	11:00 – 14:00	PURE and King County
	SmartBall Retrieval	14:00 – 15:00	PURE and King County
Thursday, August 18th	Contingency day/ Pack up equipment and demobilize Present Preliminary Results		PURE and King County

Table 2 – General Inspection Schedule

Hourly Inspection Schedule – Inspection Day

SmartBall Hourly Inspection Schedule		
Approximate Timing	**Task**	**Owner**
Pre Launch		
8:00 –8:15	Tail gate meeting at Insertion Site	ALL
	Flow rates are verified with pumps station	Client
8:00 – 10:00	Install Sensors	Pure & Client Crew
10:00 – 10:30	Flow is measured on site with insertion style flow meter	Pure
10:15 - 10:30	Initialize and synchronize SmartBall to SmartBall Receivers	Pure
10:30 – 11:00	Insertion tool is prepped and mounted onto client's flange	Pure
10:30 – 11:00	Crew 2 moves to first tracking location past insertion site	Pure & Client Crew
	All teams confirm readiness for inspection	Pure & Client Crew
11:00	Release SmartBall into flow	Pure
Inspection		
11:00	Crew 1 tracks SmartBall as it leaves insertion site	Pure
	Crew 2 confirms SmartBall has passed sensor location 2	Pure & Client Crew
	Ball is tracked throughout the day	Pure & Client Crew
12:30	Ball is confirmed at extraction site	Pure
Retrieval		
12:30 – 13:00	Remove SmartBall from pipeline	Pure

Table 3 – Expected Schedule for day of Inspection

Tool Tracking Locations

During the inspection, above ground tracking of the SmartBall tool will be performed. The proposed tracking frequency is once every half a mile (less than 1km) and will allow real time tracking of the tool's progress through the pipeline as well as aid in leak location accuracy during analysis. The SmartBall™ Receiver (SBR) device will be used as the primary locating tool and attached to the pipeline.

An SBR is a unit that detects an ultrasonic signal emitted from the SmartBall. Specific location points have been chosen along the line. These points were selected based on the position of the various assets along the line, such as air valves, TEE's, butterfly valves and where the SBT's may get best reception.

This will necessitate attaching a small 2"x 2" square acoustic sensor along the length of the inspection by grinding clear a small patch of metal and gluing the sensors in place as shown in Figure 4 below. Upon completion of the survey, the sensors can easily be removed if desired.

These sensors must be glued directly to a flange that is connected to the pipeline, or at the base of a riser connected directly to the pipeline. In general, this sensor site cannot be further than half of one meter (1 foot) from the flowing water of the pipeline, and not above any valve or other appurtenance that may inhibit the sensor from detecting the sound being transmitted from the SmartBall.

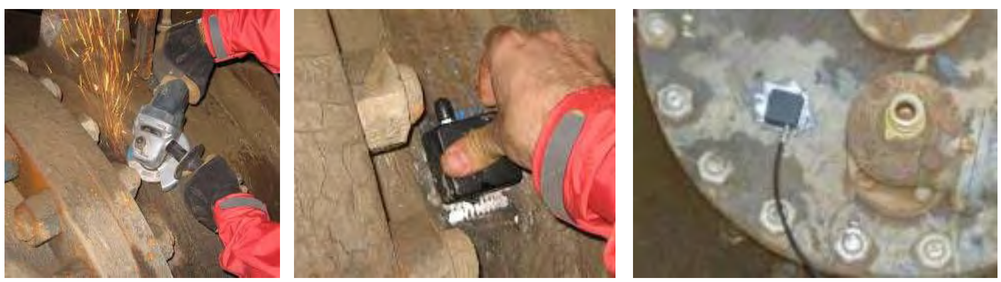


Figure 4 – Acoustic sensor glued to flange

During the inspection, two crews are required for tool tracking Tool tracking will be performed by "leap-frogging": The crews will have a list of the present tracking sites along the line where pipe tracking is to be performed. The tracking will proceed as follows: when tool is launched at the beginning, Crew Number 1 and Crew Number 2 will be at their designated features according to the below table; after confirming the tool has passed at their location, Crew Number 1 will move to their next location which is downstream of Crew Number 2's location, subsequently, Crew Number 2 will locate the tool at their location and move to the next preset location downstream from Crew Number 1.

The two teams will communicate with each other continuously to confirm tool passage and to relay the Expected Time of Arrival (ETA) of the tool at the next planned tracking location. Both teams will also communicate all confirmed locating times and associated locations to a team member who will track the progress of the SmartBall throughout the pipeline.

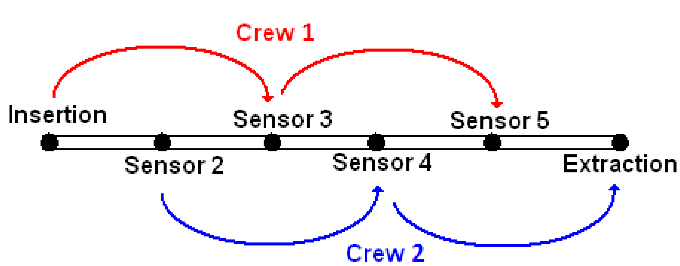


Figure 5 – Example coordination of tracking crews

The following table incorporates all the planned locating points, the locating team assigned (Crew 1 or Crew 2), and the distance between these points.

Feature No.	Feature Description	STA	Reference Location (Cross Street or Landmark)	ETA of SmartBall (based on 80% of expected flow rate)	Crew
1	6” tap	0+00	North Beach Pumping Station	0 minutes	1
2	Gravity Connection	64+58	Carkeek Park	80 minutes	2
3	Meter Vault	70+94	Carkeek Treatment Plant	90 minutes	1
4	Wet Well		Carkeek Treatment Plant	95 minutes	2

Table 4 – Proposed Example coordination

Where traffic conditions dictate, full traffic management will be erected prior positioning the survey vehicle.

Pure will require the assistance of King County to provide the necessary traffic control to comply with local regulations. A crew will be at each location for approximately half of an hour. If more extensive traffic management is required, King County may need to provide this service or contract a qualified third party.

Pipeline Flow:

The above table (Table 4) is based on the expected flow rate of 1.5 ft/s as communicated to Pure.

In order to traverse some of the steeper slopes in the pipeline, a minimum flow rate of 0.5 m/s (1.5 ft/sec) is typically required for the duration of the run. Below is an example of the flow rates required for the SmartBall to traverse various inclines.

Figure 6 – Example of the SmartBall’s ability to traverse slopes in a transmission main

To ensure that the ball inspects the section of pipe intended it is required that the flows to all off takes and branches that have product flowing out of the pipeline are closed.

The SmartBall® run is approximately 1.3 miles in length and can be surveyed in a single run. Assuming an average flow rate of 1.5 ft/s the ball should be able to traverse the pipeline and arrive at the extraction in less than one and one half (1.5) hours.

Site Preparations

Valve opening:
In general, insertion and extraction sites require a 4-inche (100mm) or 6-inche (150mm) full port valve mounted directly to the pipeline with no bends (vertically off the crown of the pipe for extraction). SmartBall equipment will not pass through and diameter less than 3.5" therefore this is the minimum internal diameter of the opening from the gate valve to the pipe. Because of the variations possible in valve installation, it is recommended that a 6" (150mm) valve and riser are used where possible so that these variations do not interfere with the inspection. The gate valve must have an ANSI Class 125 or Class 150 (PN16) flanges with standard 8 bolt patterns.

Headroom Clearance:
In addition, a minimum of 8 feet (2.5 meters) of headroom is required above the top of the gate valve at the insertion site, and unlimited headroom is required at the extraction site. This headroom past the valves provide a minimum opening of 8inches (200mm) in diameter

Insertion Site Details:

The SmartBall will be inserted via a 6-inch hot tap located on the grounds of the North Beach pumping station.

The tap will be added by Road Construction. There must be a minimum of 8 feet (2.5 meters) from the top of the isolation valve to the chamber roof.

Figure 7 Picture of North Beach pumping Station

Extraction Site Details:

The SmartBall will be extracted via the bar screen and rakes located the Carkeek Pumping Station. Once the SmartBall arrives it will be raised out of the chamber by the automatic rake. The grinder used to dispose of material collected by the rake will be turned off during the inspection to prevent the SmartBall from being damaged.

Figure87 –Extraction Chamber Photo (located at Carkeek Pumping Station)

Inspection Stakeholders

Inspection Stakeholders		
Person	**Contact Information**	**Role/Duties**
Mark Lampard Project Manager King County	T 206-263-3162 Mark.Lampard@kingcounty.gov	King County Project Manager
Brian Ball Project Engineer Pure Technologies	M 410-245-3826 brian.ball@puretechltd.com	SmartBall Inspection Leader Main PURE contact onsite
Adam Ostovitz Field Technician Pure Technologies	T 905-624-1040 M 416-550-2711 adam.ostovitz@puretechltd.com	SmartBall Technician
Michael Livermore Regional Manager Pure Technologies	T 217-419-4729 michael.livermore@puetechltd.com	PURE contact for contractual matters

Risk Management

SmartBall Risk Management			
Event / Risk	Possible Outcome	Preventative Measures	A
Higher than expected flow rates	1. SB gets ahead of tracking crew • Decrease in the accuracy of the leak location • Confusion during the inspection as to where the ball is located • Unable to effectively time lateral closures 2. Retrieval net malfunctions • SB is not caught at the extraction point • Difficulty pulling up the net (bent) after the SB is caught	1. Measure the flow rate in the main line prior to deployment. 2. Effective and timely communications between tracking team and pump operators 3. Adjust tracking plan based on actual SB velocity measured w the SBR 4. Minimize flow changes during the inspection	1. Send at leas downstream to the extrac 2. Ask the pum the pumps 3. Be prepared location
Open Lateral	1. SB travels down the open lateral • Stops the inspection • Damage to a pump • Blocks a smaller line	1. Close all laterals	1. Confirm SB p 2. Decrease flo SB down. 3. Determine w additional ac 4. Attempt to b
Inline valve not entirely open	1. SB becomes stuck in valve • Stops the inspection	1. Open all inline valves fully prior to inspection.	1. Confirm SB p 2. Slowly open 3. Increase and 4. Wait 1 day t Continuously 5. Shut down t the SB
SmartBall Becomes Lodged at an Unknown Feature	1. SB becomes stuck on an unknown feature • Stops the inspection	1. Thoroughly review drawings	1. Confirm SB p 2. Re-check dra 3. Increase and 4. Wait 1 day t Continuously 5. Shut down t the SB

SmartBall Risk Management			
Event / Risk	Possible Outcome	Preventative Measures	A
SB tracking stops working	1. SB becomes temporarily lost • Confusion during the inspection • Decrease in the accuracy of the leak location • Unable to effectively time lateral closures	1. Test both SBRs ability to detect the SB prior to launch 2. Ensure that the SBR sensors are working the day before the inspection	1. Go back to t confirm the that point. 2. Confirm that • If n SBR • If w 3. Install interr successful de 4. If all else fail and look for

SBR location is not reached in time	1. SB becomes temporarily lost • Confusion during the inspection • Decrease in the accuracy of the leak location • Unable to effectively time lateral closures	1. Ensure all crews know the timing and location of all SBR locations (even those that are not assigned to them) 2. Plan sensor locations to provide adequate time to travel between sites 3. Plan inspection during non-heavily trafficked times.	1. Go back to t confirm the that point. 2. Install interr successful d 3. If all else fail and look for
SB Does not arrive at SBR location at planned time	1. SB becomes temporarily lost • Confusion during the inspection • Decrease in the accuracy of the leak location • Unable to effectively time lateral closures	1. Ensure accurate flow rate estimates are provided 2. Measure flow on site 3. Ensure flow fluctuates minimally during inspection	1. Wait patient 2. Check with p 3. Check drawi change in pi 4. Confirm that • If n SBR • If w 5. Go back to t confirm the that point. 6. If all else fail and look for

Job Hazard Analysis

It is important that all work is carried out in a safe manner. If anyone on site feels the work cannot safely proceed or have not been instructed how to safely operate any piece of equipment please do not do so.

Process/Equipment: SmartBall Field Operations	**Location :** Various
Procedure Developed by : Darryl Yarrow/ Jeff Kler	**Approved by :**

Referenced Pure Technologies Guidelines, provincial, state or federal legislation, standards, etc.: SmartBall Manual, Client Government requirements for confined space entry.

Personal Protective Equipment Required (Check the box for required PPE)

Cloth, Canvas, or Leather Gloves	Chemical Gloves	Fall Restraint System	Dust Filter	Half Face Respirator	Full Face Respirator	Supplier Air Respirator	Safety Glasses	Safety Goggles	Face Shield	Steel Toed Shoes	Hard Hat	Hearin Protecti
☒	☐	☒	☐	☐	☐	☐	☐	☐	☐	☒	☒	☐

Activity *(Steps in the process/task)*	***Hazards Identified*** *(What could cause an injury)*	***Health / Safety*** *Type of hazard*	***Con*** *(What can be done to m*
Assembly and Prep Work	Cut/Crush Injuries to hands, injury due to improper assembly	Safety	Assembly training, Inspection of equ proper PPE
Mounting Sensors	Confined Space, Slip/Trip, sparks form grinding operations, Traffic Hazards at multiple locations, Vehicle accident moving to multiple locations, fumes from adhesives.	Safety/Health	Confined space training, Confined sp greater than 6 feet, mechanical vent plan, proper PPE for grinding, adhesi Follow proper vehicle use procedure recommended controls during use.
Deployment of Insertion Stack	Crush injuries, Back injuries, confined space hazards, Traffic hazards at insertion site,	Safety	Proper lifting techniques, Confined s follow client's traffic control plan, pr
Tracking SmartBall	Confined Space, Slip/Trip, Traffic Hazards at multiple locations, Vehicle accident moving to multiple locations, fumes from adhesives.	Safety/Health	Confined space training, Confined sp traffic control plan, proper PPE for a hazards. Follow proper vehicle use p recommended controls during use.
Teardown of Insertion site	Crush injuries, Back injuries, confined space hazards, Traffic hazards at insertion site,	Safety	Proper lifting techniques, Confined s follow client's traffic control plan, pr
Removal of sensors	Confined Space, Slip/Trip, Traffic Hazards at multiple locations, Vehicle accident moving to multiple locations, fumes from adhesives.	Safety/Health	Confined space training, Confined sp greater than 6 feet, mechanical vent plan, proper PPE for grinding, adhesi Follow proper vehicle use procedure recommended controls during use.
	Risk Level (Initial) Risk Level (controls in place)	(4+9)*4=52 (4+9)*2=26	Substantial Risk. Correction Requirec Possible Action Required – Proceed v (JSA/ confined space programs in place)

Frequency Of Exposure To Hazard		+	Severity Of Likely Outcome	X	Probability Of Occurrence	=	Risk
10 **9**	Continuous/ Very Frequent	**10**	Catastrophe (Multiple Deaths)	**5**	Certain To Occur	**100**	Very High Risk, Take Immedi
8	Frequent, A Few Times Per Day	**9**	Disaster (Death)	**4**	Can Be Expected To Occur	**90**	High Risk, Action Required U
6	Occasionally, A Few Times Per Week	**8**	Very Serious (Hospital)	**3**	Quite Possible	**50**	Substantial Risk Correction R
4	Few Per Month	**7**	Serious (Doctor)	**2**	Unusual But Possible	**20**	Possible Action Required
2	Rare, Few Per Year	**5**	Important (First Aid)	**1**	Unlikely	**10**	Risk Perhaps Acceptable
0	Very Rare	**3**	Noticeable	**0**	Practically Impossible	**0**	No Action Required

Risk Matrix

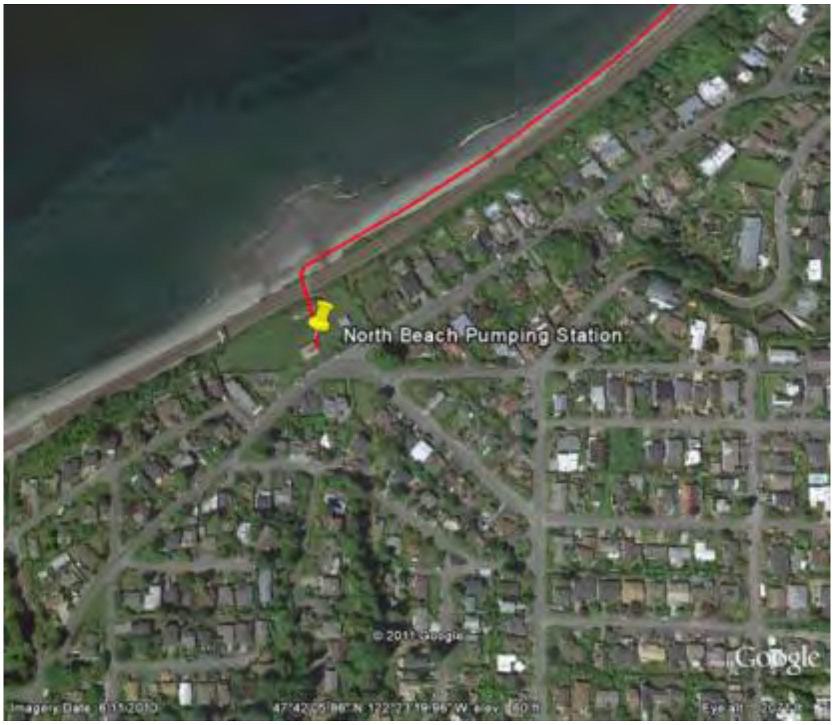
EXAMPLE:
(FREQUENCY + LIKELY OUTCOME)* x *PROBABILITY = DEGREE OF RISK

<u>(10 + 7) x 4 = 68</u>

(high risk, action urgently required)

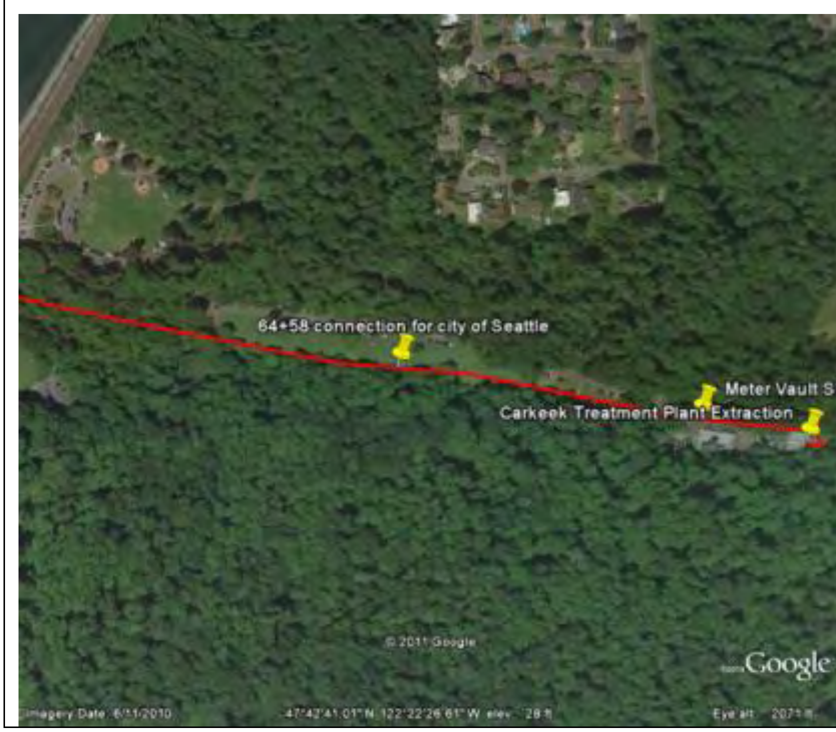
General Conditions Worksheet	Y/ N	Specify
1. Do any of the materials used in the task have an MSDS or require personal protective equipment when handling? (Refer to MSDSs)	Yes	Reference to MSDS for adhesive
2. Do environmental stresses--i.e. dust, chemical mixtures, ionizing/nonionizing radiation, welding rays, heat, or excessive noise--result from the task?	Yes	Adhesives
3. Is there any explosive hazard associated with the task or likely to develop because of the process?	Yes	Hydrogen Sulfide could be present
4. Have there been any complaints from employees of headaches, breathing problems, dizziness, or strong odors?	Yes	Carbon Monoxide, H2S and Chlorine gasses may be present
5. Is the task performed in a space which has only one entry/exit opening, is otherwise confined and/or is poorly ventilated?	Yes	Access will vary by region.
6. Does the task involve working in areas or with materials subject to temperature extremes?	No	
7. Does the task involve operating machine/hand tools, cranes, or hoists?	Yes	Hand tools and electronic equipment in use.
8. Does the task involve work on energized or de-energized equipment?	Yes	Low voltage equipment
9. Does the task involve rapid or repetitive body motions?	No	
10. Does the task involve working above floor level?	Yes	Potential for working at height
11. Does the task involve lifting, pulling pushing, or carrying heavy objects?	Yes	Assembly and removal of Equipment is necessary
12. Does the task involve work with pressurized vessels?	Yes	Pipe will have various ratings for pressure
13. Does the task involve working with or near a flame or arc?	No	
14. Does the task involve work with flammable materials?	No	
15. Does the task require specialized training prior to its conduct?	Yes	Assembly of SmartBall, Conf. space and harness training
16. Are any other unusual hazards present?	Yes	Multiple sites are covered during operation

Appendix A: Sensor Locations

<table>
<tr>
<td>
</td>
<td>INSERTION, SBR # 1
Location: North Beach Pumping Station

Latitude: 47°42'6.40"N
Longitude: 122°23'23.84"W

Distance from
Previous sensor: 0 ft

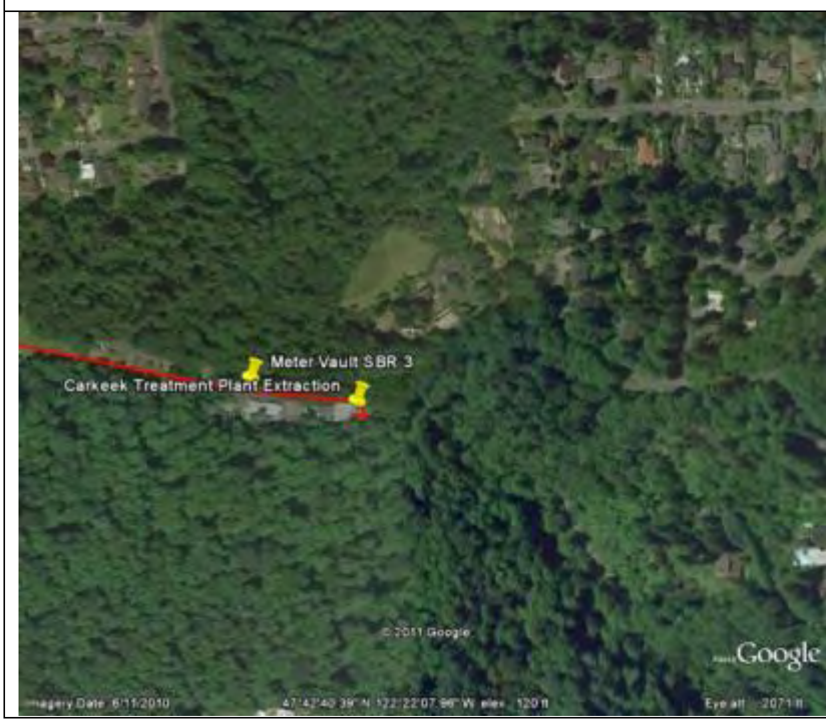
Total Distance: 0 ft</td>
</tr>
<tr>
<td>
</td>
<td>SBR # 2
Location: Gravity Connection

Latitude: 47°42'41.08"N
Longitude: 122°22'28.05"W
Station: 64+58
Distance from
Previous sensor: 6458 ft

Time from Previous: 80 min

Total Distance: 6458 ft

Traffic Control: No</td>
</tr>
</table>

 	SBR # 3 and Extraction Location: Carkeek Treatment Plant Latitude: 47°42'39.63"N Longitude: 122°22'15.50"W Station: 70+94 Distance from Previous sensor: 636 ft Time from Previous: 90 min Total Distance: 7094 Traffic Control: No

Appendix C: Revision History

Revision	Date	Description	Person
0.1	Wednesday August 24, 2011	Data Analysis	Jason Gernand
0.2	Wednesday August 28, 2011	Data Peer Review	Olive Ojala
0.3	Wednesday August 26, 2011	Report Generated	Jason Gernand
1.0	Wednesday August 31, 2011	Report Review and Submittal	Jorge Dominguez